LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twenty-eighth of the preceding month; for the second issue, the thirteenth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

The Presence of Neutral Oxygen in the Gaseous Nebulae

The most stable configuration, s^2p^4, of neutral oxygen gives rise to three terms, ^3P, ^1D and ^1S. McLennan[1] has shown that the green auroral line corresponds to the $^1D-^1S$ transition. Recently Frerichs[2] by a very exhaustive analysis of the oxygen spectrum has been able to predict the positions of the $^3P_2-^1D$ and $^3P_1-^1D$ transitions at 6299 $\pm$5A and 6363$\pm$5A respectively while a private communication to Dr. Frerichs from Professor Paschen states that he has found these lines in the laboratory at 6300.00A and 6363.86A.

Wright's[3] list of nebular lines shows weak unidentified lines at 6302A and 6364A. In agreement with the corresponding transitions in O_{III} the $^3P_2-^1D$ line is two or three times as intense as the $^3P_1-^1D$ line. The general behavior of the lines in various nebulae is in agreement with this identification.

The question at once arises as to why the $^1D-^1S$ line alone occurs under auroral conditions while the $^3P-^1D$ lines alone appear in the nebulae. The theory of the transition probability[4] due to quadrupole radiation (as these lines are "forbidden" by the ordinary selection rules no dipole radiation exists)[5] shows that the mean life of the ^1D state before transition to the ^3P level is much longer, since it is an intercombination line, than that of the ^1S state before transition to the ^1D state. On the other hand the number of atoms reaching the ^1S state is much less than that reaching the ^1D state. This follows from the fact that nearly all of the atoms reaching the ^1S state make the $^1D-^1S$ transition and thus arrive at the ^1D state in addition to those that reach there directly. Since the ^1D state has lower energy than the ^1S state the number reaching it directly is also greater than that reaching the ^1S directly.

Under nebular conditions the mean time between impacts with other atoms is large compared with even the longest of these mean lives and consequently the intensity of the lines is determined largely by the number of atoms reaching the respective upper states. Consequently we should expect the $^1D-^1S$ transition to be much weaker than the $^3P-^1D$ transition. This is verified by the observation that in O_{III} and N_{II}, which have the same set of low terms, the $^1D-^1S$ line is 1/20 to 1/50 as intense as the $^3P-^1D$ lines. A corresponding ratio in O_I would give the $^1D-^1S$ line at 5577A an intensity much below the limit that could have been observed, as the $^3P-^1D$ lines are fairly weak.

On the other hand under auroral condition the collisions between atoms are so frequent that the atom in the ^1D is almost always taken out by a collision of the second kind before it can radiate the $^3P-^1D$ lines. The $^1D-^1S$ transition, however, has a high enough probability so that even under auroral conditions it can take place before a collision of the second kind removes the atom from the ^1S state.

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Pasadena,
July 19, 1930.

[1] McLennan, Proc. Roy. Soc. **A120,** 327 (1928).

[2] Frerichs, Phys. Rev. in press.

[3] Wright, Studies of the Nebulae, Lick Observatory, p. 242.

[4] Huff and Houstoun, Phys. Rev. in press.

[5] Frerichs and Campbell, Phys. Rev. **36,** 151 (1930).